# Rough Location - Abstract

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Large effort is being spent in "the full integration of geospatial data and geoprocessing resources into mainstream computing and the widespread use of interoperable, commercial geoprocessing software through the global information infrastructure" (OpenGIS 1998, p. iii). Interoperability is "the ability for a system or components of a system to provide information portability and interapplication, cooperative process control" (OpenGIS 1998, p.74).

A clear understanding of the ontological and epistemological status of location is a basic precondition to achieve these goals. A clear understanding of the ontological status of location, i.e., what location is, is the basis for shareability of geospatial information. A clear understanding of the epistemological status of location, i.e., what do we know about the location of things, is the basis for representation of geospatial data.

In this thesis a unified view on ontological and epistemological aspects of location is provided. The ontological analysis results in the distinction between exact, part, and rough location. Based on this distinction a formal analysis of location is provided. The epistemological analysis shows that for geospatial objects only part and rough location can be known and represented.

Spatial objects are located at regions of space. Exact location is a relation between an object and the region of space it occupies. Spatial objects and spatial regions have a compositional structure, i.e., are made up of parts. The ways in which parts of objects are located at parts of regions of space are captured by the notion of part location. There are multiple ways how parts of spatial objects can be located at parts of regions of space. In this thesis multiple part location relations are identified and a classification of these relations is provided.

Rough location refers to location of spatial objects with respect to sets of regions of space that form regional partitions of space. Rough location is characterized by sets of part location relations relating parts of objects to parts of partition regions. Rough location can be considered as an approximation of exact location in terms of part location in a regional partition.

The formal analysis provided in this thesis discusses formal models of exact, part, and rough location, relations between exact, part, and rough location;

operations on rough location and their relations to operations on exact location, and aspects and assumptions of the representability of location a computer.

The application of concepts of location to spatial information systems has another aspect. It involves human knowledge about spatial objects and their location in space. Aspects of epistemology, need to be considered.

One major aspect of the epistemological discussion in this thesis is that from empirical means, i.e., from observation and measurement, for almost all phenomena in geographic space all we can ever know is rough location in regional partitions. These regional partitions are created or selected by the observation and measurement processes. We do know that there exists one and only one region at which spatial objects are exactly located in each moment in time. In general we do not know the identity of this region. We do know approximations of exact location in terms of rough location in regional partitions.

Geographic information systems (GIS) are supposed to model geographic reality based on their internal representation. They represent human knowledge and data resulting from observation and measurement of geographic reality. Consequently, they need to be suitable to represent rough location.

In practical GIS design it is often ignored that the exact location of most spatial object is unknown, or not finitely representable, or both. The analysis in this thesis shows that the representations used in most GIS are incomplete representations of rough location. Consequences are representation errors, inconsistencies, non-shareability of spatial data, and the non-interoperability of the different systems.

In order to overcome these problems in this thesis formal models for geographic objects that take

- the ontological distinction between exact, part, and rough location, and
- epistemological aspects of human knowledge about exact, part, and rough location

into account.

An important aspect of modeling of geographic reality is to perform operations. The analysis in this thesis shows, that operations on rough location are different from operations on exact location. It is shown that pairs of rough operation approximate union and intersection operations on exact regions of spatial objects.

This thesis verifies the hypothesis that rough location is an important concept for representation and modeling of geographic objects on a computer. In order to support sound representation and reasoning as well as interoperability and data exchange the distinction between exact and rough location needs to be made explicit in the underlying representation.

## References

OpenGIS (1998), The opengis guide, Technical report, Open GIS Consortium.